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THE AMERICAN JOURNAL OF PSYCHOLOGY

Founded by G. STANLEY HALL in 1887

VOL. XXIII

JULY, 1912

No. 3

FURTHER EXPERIMENTS ON THE INHIBITION OF SENSATIONS

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§ 1. *Introduction.*—Inhibition may be defined as the reduction of any conscious activity while the stimulus is in operation and undergoes no corresponding diminution. The reduction may be either partial or complete, but must not be due to fatigue. This definition is strictly empirical, and is designed to cover all past work in the psychological field. We may add that while the loss may conceivably be of intensity, extent, or any other attribute, each type needs to be experimentally demonstrated.

Examples of inhibition of intensity were reported in a paper of last year (*Psy. Rev.*, Jan., 1911). It was concluded that sensations of certain types, at least, may have a diminished intensity owing to the presence of certain other sensations. We found that this kind of inhibition was dependent upon the attention of the subject: when he was trained to increase his attention to pressure sensations, for example, these were no

longer inhibited by the sound sensations; and when, on the other hand, he increased his attention to the sounds, these diminished the pressure sensations most markedly.

In order to learn whether these results could be extended, I undertook more experiments last year at Cornell University. The observers were Miss Mabel E. Goudge (graduate student), Mr. E. G. Boring (assistant in psychology), Mr. A. S. Edwards (graduate), and Mr. C. A. Ruchmich (present instructor). G and B worked three hours per week and E somewhat less during both terms; R gave this number of hours during the first term.

PART I

The Effect of (Strong) Auditory Sensations on the Intensity of Simultaneous Odors

§ 2. *Procedure.*—The sounds were made with an electrical buzzer placed near the left ear, and were thus of fairly constant character. With an olfactometer the odor stimuli were varied in strength at will. (See Appendix, § I.) Also we needed to measure the intensities of the odor sensations, and our way of doing this may be explained as follows: We choose two stimuli, S and C, and find the number of times out of eight that C is called fainter than S. Now it is evident that the weaker a sensation is, the more times will it in the long run be called weaker than a certain constant other one with which it is compared. Therefore, if the sensation from stimulus C given with the sound is more often called weaker than when given without the sound we may conclude that the sound has reduced the intensity of the sensation of C.

Accordingly we give our odors in pairs,—S-C and S-C (with sound). Two more pairs arise upon changing the order,—C-S and C (with sound)-S. In Table I are shown the various strengths of the odors used for each observer. For Observer B what we have just called S appears as the figure 11, while C is represented by 3 and again by 18. Thus we plan to find the number of times out of eight that 3 is called fainter than 11, when the former occurs with and also without the sound. Similarly with 18 and 11. We have stated this method of calculation at greater length in the previous paper.

The way of getting the odors was this: The signal 'Ready!' came first, followed soon by 'One!' when the observer placed his nostril over the opening of the tube and inspired; next he removed the nostril and awaited the second signal, then took the second odor and said which was stronger.

TABLE I.

	Observer B		Observer G		Observer E		Observer R	
	First Odor Given	Second Odor Given	First Odor Given	Second Odor Given	First Odor Given	Second Odor Given	First Odor Given	Second Odor Given
A	11	3	7	3	8	3	10	3
B	3	11	3	7	3	8	3	10
C	11	3/n	7	3/n	8	3/n	10	3/n
D	3/n	11	3/n	7	3/n	8	3/n	10
E	11	18	7	11	8	13	10	17
F	18	11	11	7	13	8	17	10
G	11	18/n	7	11/n	8	13/n	10	17/n
H	18/n	11	11/n	7	13/n	8	17/n	10

In Table I are shown the various pairs of odors given to each observer. The figures stand for the strength of the stimuli, expressed in half centimeters of exposure of the odorous cylinder. The capital letters stand for the pairs of stimuli, e.g., the A-pair for Observer B is 11—3. The sign /n indicates the occurrence of the sound.

Experiments in this field of inhibition need to be carried out with great care, and we give in the Appendix a list of precautions which were observed. (See Appendix, § 2.)

§ 3. *Results and Discussion.*—Figures which show the intensities of odors as judged with and without the sound appear in Table II.

TABLE II.

		Observer B		Observer E		Observer G		Observer R	
Series 1-A									
A	C	6 1/2	1 1/2	5 1/2	6 1/2	6	6 1/2	4	5
B	D	2 1/2	2 1/2	5 1/2	5 1/2	6	7	5	1
A+B	C+D	9	4	11	12	12	13 1/2	9	6
E	G	3	1 1/2	3 1/2	3 1/2	3	1 1/2	0	4
F	H	2	2	1	1 1/2	2	2	0	1
E+F	G+H	5	3 1/2	4 1/2	4	5	3 1/2	0	5
A+B+E+F C+D+G+H		14	7 1/2	15 1/2	16	17	17	9	11
Series 1-B									
A	C	6 1/2	3	7 1/2	7 1/2	6	8	5	7
B	D	5 1/2	3 1/2	6	6	7	8	1	3
A+B	C+D	12	6 1/2	13 1/2	13 1/2	13	16	6	10
E	G	2	5 1/2	3	1 1/2	2	2 1/2	4	0
F	H	1	3	1 1/2	1 1/2	1 1/2	2 1/2	1	1
E+F	G+H	3	8 1/2	4 1/2	2 1/2	3 1/2	5	5	1
A+B+E+F C+D+G+H		15	15	18	15 1/2	16 1/2	21	11	11

TABLE II—*Continued*

Series 1-C

A	C	7½	6½	5	4
B	D	6½	6	8	4
A+B	C+D	14	12½	13	8
E	G	4	3½	5	4
F	H	0	1½	1	1
E+F	G+H	4	5	6	5
A+B+E+F C+D+G+H		18	17½	19	13

Series 1-D

A	C	4½	4	6½	7½	7½	7	6	3
B	D	6½	4	7	3½	5½	6	4	4
A+B	C+D	11	8	13½	11	13	13	10	7
E	G	4	2½	4½	4½	3½	3	3	0
F	H	2½	1	½	2	1½	0	7	0
E+F	G+H	6½	3½	5	6½	5	3	10	0
A+B+E+F C+D+G+H		17½	11½	18½	17½	18	16	20	7
Total sum		46½	34	52	49	69½	71½	59	42

Figures opposite single letters in Roman type (A or B or E or F) in each case represent the number of times out of eight that the odor from a certain stimulus was judged fainter than a certain other (see Table I); while in the space to the right of each such figure in Roman is a corresponding figure in italic which represents the number of times that the odor from the same stimulus was judged fainter than that from the same other stimulus when the sound was made simultaneously with the former. For any observer it will be seen that the italic figures are not generally nor in their sums (markedly) larger than the Roman; therefore the figures fail to demonstrate that the sound generally inhibited the odor.

The above figures, as explained in the note under the table, do not permit us to conclude that the sound sensation generally inhibited the odor. In fact, the odor with the sound seems rather to have had an augmented intensity.

The results were unexpected for two reasons: first, because they were unlike those attained in the previous experiments under similar circumstances, where pressures and sounds had been judged;¹ and secondly, because the observers at the beginning of the series had themselves occasionally mentioned the odor being blotted out or cut off by the sound.

Accordingly we needed to explain this difference. In daily life, as is well known, distractives often are overcome by increased effort to attend. More particularly, I have shown cases where pressures were robbed of the inhibitory effect they

¹ *Op. cit.*, *Psy. Rev.*, Jan., 1911, §§ 4, 7, 18.

tended to have on sounds, when the subject attended to the sound as strongly as he could.² Indeed under these circumstances the sound sensation even seemed to be stronger than when it occurred with normal attention and no simultaneous pressure. These facts lead to the hypothesis that by added effort to attend to the odor when the sound came, the observers in the present series had counteracted the inhibitory influence of the sound, and so turned the scale as to result in a positive augmentation.

§ 4. *Introspections*.—Observers R and B had, in the work just described, spontaneously mentioned such effort to increase attention to the odor when the sound came; G and B each had done the same at least on one occasion. Partly in order to learn whether such added effort characteristically occurred with the sound under our conditions, I undertook to obtain a series of detailed introspective analyses of the situation. (See Appendix § 3.)

Of course the experimenter did not speak of effort to the observers. That would have been contrary to the policy of our introspective work, which requires that the observers be left to report on what they find without interfering suggestions. They were trained to give accounts of "everything that occurred in consciousness in temporal order" from the first signal to the utterance of judgement. Excerpts from these reports show how effort sometimes appeared when the sound came:

Observer B.—"Prolonged auditory sensation (from the buzzer). With it, I think, were kinaesthetic sensations in head and in back (meaning a brief, weak start). After this, but still with the auditory sensations, there came weak, unpleasant organic sensations (meaning disturbedness and *effort to image or sense the odor*)."

Observer G.—"Olfactory image or sensation, and simultaneous muscular sensations, principally in center of chest, and in the region of the nose and temples; also there were strain sensations in the chest and temples (those in the chest being due to holding the breath, and those in the temples perhaps due to holding breath, but also to *the purpose to keep out other stimuli than the olfactory*)."

Observer R.—"Kinaesthetic sensations in trunk, legs, neck, (movements to get odor) and scalpular sensations at the side of head and contracture sensations in forehead (concentration upon image of odor following). Meanwhile the image of odor and feeling of unpleasantness are present, but decrease toward the close."

The effort to attend, however, was only one of numerous kinds of effort which the reports mentioned and analysed: there also were efforts or strains to retain, judge, introspect, breathe, and listen for the experimenter's signal. Some one

² Ibid., Series 6, p. 48.

of these efforts was reported in each of most of the introspections, but the effort to attend failed to appear in very many of them, and furthermore, it often occurred during the tests in which the distracting sound was absent. These introspective reports, therefore, did not give adequate warrant to the conclusion that "added effort characteristically occurred with the sound under our conditions." (See above p. 349.) Nevertheless, they did give us positive instances of the occurrence of such effort, and we decided to test the matter further in the manner described in the next chapter.

PART II

The Abandonment of Effort of Attention

§ 5. *Methods*.—If the sound sensation in Series I was robbed of its inhibitory influence by special effort of attention on the part of the observers, we might expect, by doing away with this effort, to restore the inhibition. Plainly to tell them to avoid effort when the sound came seemed suggestive and unwise, and therefore the experimenter took a roundabout means. To each he first read a list of his past introspections, wherever they had mentioned effort, and then gave the following instruction: "Not to continue to exercise effort of any sort at any time during the entire process. To abandon all attitude of effort and be quite as passive as possible."

As it was necessary to learn how the instruction was working, in order both to understand and to control the situation, we made records not alone of the judgments about intensities, but of two other matters as well:

1. The observers gave introspective reports how the instruction was being carried out, telling especially of any effort that had been present. On some days they gave such an account after each eight judgments; on others, after the whole hour's work. Whenever any kind of effort was mentioned, the experimenter drew special notice to it, and suggested that it be abandoned.

2. The experimenter took records of the "behavior" of the observer.

It was plainly noticed that in this there might occur much variation: The observer's brows may be wrinkled, and his mouth compressed, or both may be smooth and expressionless; the muscles of his trunk and limbs may be alert and contracted, or they may be flaccid and inactive; he may breathe in the odors jerkily and utter judgment abruptly and vigorously, or may maintain the quietness of sleep and speak in a soft whisper; may talk in lively fashion, or may say practically nothing.

In short, he may be alert and tense in this or that part of the body, or may be inactive and relaxed.

Now it was found that with increase of effortlessness, as reported by the observer, there was an increase of relaxation and inactivity as externally manifested. Marked deviations were noted, but this correlation seemed to hold as a very rough, but fairly serviceable generalisation. And there seems to be a good reason why it should hold; for the observers all found that in order to carry out the *Aufgabe*, they had to 'relax'; and it is obvious that relaxation may be manifested in behavior as well as in introspection. In other words, effort is a psychophysiological condition which reveals itself not alone in certain mental processes (strain sensations, etc.), but in external behavior as well.

At first the records of behavior were taken sporadically, but later a system was developed. Then, as a rule, with every set of eight judgments the experimenter recorded the degree of (1) facial relaxation, (2) bodily relaxation, exclusive of the muscles concerned in maintaining the sitting posture, (3) jerkiness of respiration, (4) quietness of voice, (5) talkativeness. Sudden palpation was sometimes used to gauge bodily relaxation. The above particulars were each time recorded as of degree 0, 1, 2, 3, 4, 5, the last number representing the maximum. We give two examples, both of Observer E, the first taken when he had not yet had much practice in attaining effortlessness.—“The observer shakes his head, wrinkles his brow, and speaks in strong perplexed tones. He takes quick, irregular breaths, and his voice is no more calm than in Series 1.” A record from a later time, when he had become better at the task, shows him much more relaxed and inactive, to-wit:

f = 4
b = 4
r = 1
v = 2
t = 0

This schema made it possible to take records very quickly. The observers were never informed of this, since we wished them to be spontaneous. When activity rather than quietness and relaxation was shown, the observer was specially instructed and urged, in general terms, to increase his attempts to get the effortless condition. (See Appendix, § 4).

The odors were given in about the same way as in Series 1: Upon signal the observer took a half-second breath from the tube, practice having made this habitual; after removing the nostril he awaited the second signal, which came three seconds after the beginning of the first inspiration; then he took another half-second breath and said which odor was stronger. The sound occurred in one-half of the tests either with the first or second odor. (See Table I; also Appendix, § 5.)

§ 6. *Results*.—We shall first quote from the records in order to trace how each observer did away with effort.

Observer B.—At first B stated that the effect of the *Aufgabe* had been to remove “nearly all those efforts that you described in reading those introspections” (see p. 350). Nevertheless, the immediately

subsequent reports, including all of those for the first three or four hour-sessions, speak of effort. For example: "Sensations of strain about the neck, also vague strain sensations in head and at times in body occurred noticeably before giving the judgment 'Equal,' and also during sounding of the buzzer, especially when this appeared prolonged—and occasionally when the odor was not sensed as soon as the nostril was placed on the tube. These strain sensations are the same as those which constitute the greater part of the feeling of effort. When the buzzer comes there is a feeling of uncomfortable tension, which is particularly marked if the sound is prolonged. It is the sort of feeling that always produces bodily strain. Perhaps that is due to my trying not to attend to it; I don't know." At this time also the signs of behavior do not indicate effortlessness; there are "quick, jerky movements away from the tube, and his utterances are somewhat jerky and abrupt." A little later we still find him saying, "The whole period of the sounding of the buzzer is very different from other periods. There is a strong, unpleasant affection, and a consciousness of the presence of a disturbing factor; I feel confused, disturbed, uncomfortable, as if in an unnatural situation."

Marked improvement soon sets in; the breaths remain jerky, and there is still some muscular tenseness, but the signs are generally quieter. We read, "Very little feeling of effort, if any. Strains in body, arms, neck, forehead, eyelids, and top of head vaguely noticeable; I believe these are always present in some degree if attention is turned to them; but they are very obscure and appeared only when the idea, 'Am I straining?' came into consciousness. — Judgments seem to come much more mechanically than usual, and I have a positive kinaesthetic 'feel' of relaxation —." Relaxation (including the absence of strains localized in the brain) is stated by the observer to be equivalent to absence of effort (See Appendix, §6).

Improvement continues.—The muscles of face and body show a high degree of relaxation (degree 4, as a rule), respiration and voice are subdued, and talking is at a minimum. Reports read: "Felt perfectly passive," etc. "Seems to be no effort at all except very seldom.—Was conscious of vague pressures and strain—my self-consciousness, —but that is all." Indeed at this stage the observer has made so much progress toward passivity and effortlessness that he falls asleep at various times during the hour's work, especially at the pauses between the sets of eight judgments. Nevertheless the signals arouse him to go through the task and judge in mechanical manner. "The general dozing condition", he reports, "is made of distinct organic sensations in arms, legs and body (a definite, positive 'feel' of relaxation). There is a slight strain of different character in the back (meaning physical effort to hold the body in position relatively to the tube). The most intense sensations present come from the eyes, and are similar to the peculiar strains experienced when going to sleep; (these carry a meaning, 'My eyes are becoming closed,' entirely different from 'I am closing my eyes.' The former is very passive). Tactual sensations from weight of head on hand or other support (meaning relaxation) also are prominent. The whole of consciousness may be said to be rhythmical. Even breathing seems to be accompanied by rhythmic variations in the kinaesthetic complex.

"The acts performed in connection with smelling appear also to come rhythmically. Each one is preceded by vague visual and kinaesthetic images, which are followed by a slow motion whose time is felt kinaesthetically (image) beforehand. The motions following the

signals go off almost automatically. The verbal idea frequently appears 'I don't care what happens.' (The observer had been instructed that he need not concern himself about anything so long as he attains the desired state of effortlessness. He may even omit passing judgment if necessary.) This phrase is especially frequent when judgment does not follow immediately after the second stimulus.

"There are really two sorts of consciousness. In the dozing sort there is complete reverie. Consciousness does not lapse, but may lose all logical connection and all reference to the surroundings and the situation. At the first signal there is a feeling of 'heightening' of consciousness. By this I mean that I have a visual image of raising something up in my brain. There are also kinaesthetic images or sensations in the shoulders, and a slight feeling of restlessness and constraint carried by kinaesthetic sensations in the head. I have not called this effort in the past; it is too vague and uncertain, and is more of an attitude than a separable component. When judgment comes of itself I lapse immediately into a state of reverie with a few kinaesthetic changes. If judgment does not come at once, there is a feeling of suspense carried kinaesthetically in the chest and elsewhere and followed by judgment, or sometimes, in the event of failure to get judgment, by the utterance 'equal.'"

A final statement of the observer shows further how he did away with effort. "Effort is very likely to occur when the attention is not on the matter in hand, but may be inhibited, I think, for instance, by the phrase, 'I don't care what happens,' or 'I don't care whether I judge or not,' since in these last series I knew that if necessary, I did not have to bother to judge. Sometimes the idea 'I must not make any effort' increases effort. (Question: In attempting to abandon effort did you make any use of effort to attend positively to something else?) No! (with certainty) to attempt to attend positively to anything else means to me to attend with effort. On the other hand, I frequently did avoid effort by attention to something else, but the attention did not come voluntarily; there was no attempt to attend."

Observer G.—The first report reads, "Before the signal 'Ready' I was more relaxed (than in the previous series); did not thrust back any ideas trying to come in. After the signal things seemed to be as usual, except that there was muscular relaxation more or less all over, but especially in the head and temples; and in the period between the odors there was not such strain as usually occurs." From now on G typically gives a brief report, in which she compares her present condition with that of the previous series: "1. Greater muscular relaxation. 2. Ideas not relating to the task occurring in the fore- and mid-period were not actively thrust back. 3. I felt a 'tightening' at times, which I at once tried to banish." The reports for most of the periods practically are repetitions of the above, some of them omitting (3). (See Appendix, §7.)

As to behavior, moderate or good facial relaxation with deliberate breathing and subdued voice was attained, but there was more or less retrogression at times to the quick reactions that characterized the previous series. Towards the last the observer reported maximal relaxation, and at this time an average of four behavior records reads $f = 3$, $b = 3$, $r = 4$, $v = 3$, $t = 2$, showing a fair, but not an exceedingly high degree of external relaxation.

Asked for a brief and general account of how it felt to go through the process in the relaxed state, the observer replied, "Before the first signal I got the conditions, and remained more or less conscious of the

relaxation and calmness during the experiment; with these exceptions consciousness, so far as I remember, was the same as in the previous series." Her way of bringing about effortlessness, she added, was by keeping her hands from being clenched and tense, by eliminating strains from the head, and by making her body as limp as possible. Questioned how she 'banished the tightening' she replied that all she could say was that she just relaxed again; "It involved a consciousness of being tense, and that I must not be tense,—not verbally spoken, of course."

Observer E.—He discusses his first response as follows: "At first arose the verbal idea, 'relax!'; I found an easy position and tried to get as comfortable as possible; so far as I could I relaxed all muscles, then waited to let my ideas or sensations appear. Attitude was that of one ready to follow the impulse of the moment. I noticed the comfortable feelings of breathing and having eyes closed, and the pleasure which came from allowing my thoughts to arise without any effort, unlike the past." On the next day he adds that smelling and judging occurred quite mechanically. The behavior, however, does not indicate effortlessness and passivity, and special instructions to get this condition are repeatedly given. On the fourth day muscular relaxation sets in, though other signs are of normal activity; but his introspections do not change in tone. Various sorts of effort are reported at times, but usually the operations are called automatic.

Once he remarked, "The noise was very unpleasant. I did not set myself to overcome so much noise." Questioned as to the nature of this 'setting,' he replies, "First a consciousness (of the task, namely, to be relaxed as much as possible and still to smell and judge upon signal. This becomes relatively unconscious, and the appropriate act automatically follows the signal.)" At the time he was unable to analyse this consciousness. Later he speaks more definitely when asked, "What happens when the buzzer sounds?"—"Auditory sensations of noise, generally in the background of consciousness,—not much noticed. Muscular sensations in chest (from slight effort to overcome distraction caused by buzzer). Also organic sensations, not definitely localized, (but due to shock and intensity of noise). A slight tightening of diaphragm, I think, (also due to shock). There is rather more effort when the buzzer sounds, as shown by these muscular sensations, which are not so apparent without the sound." (See Appendix, §8.)

The factor whose presence we suspected is here plainly disclosed for this observer; and at this late date, when more than half the series is over, has not yet been banished. He had believed that he could not judge at all, if this effort during the noise were banished. Upon this the special instruction was given that he abolish it, and after some trouble he reports success. The typical report for the last part of the series is, "No effort recalled." (There is no corresponding decrease of activity shown in behavior, but rather a slight increase on the whole in muscular tone. However, the signs show a fair degree of relaxation and inactivity,—averaging $f=3.5$, $b=4$, $r=1$, $v=2$, $t=7$.)

The records for the three observers may in summary be said to have seven essential elements in common: They find (1) various kinds of effort, and among these (2) special effort to attend when the buzzer sounds. (3) Effortlessness is

identified with relaxation, and (4) the state is brought on by self-imposed instructions such as "Relax!" or "I don't care what happens!" carried verbally or otherwise. Then (5) effort diminishes and external relaxation and inactivity increase, until towards the close of the series (6) a high degree of effortlessness is attained, and (7) the processes of smelling, attending, and judging become mechanical and automatic.¹

For each observer, therefore, the attention to the odors finally becomes fairly passive and effortless, and special concentration to overcome distraction is probably abandoned.

How have the reported intensities of the odors thereby been affected? Turning to Table III, one is disappointed, if he has expected to find evidence that the sound now exerts a marked inhibitory influence. In the case of G it seems to have been inhibitory, as shown by the sums at the bottom of the table; but for B the effect, if any, has been small, while for E it has amounted to nothing.

Upon comparing Table III with Table II, however, it is seen that there is some difference. While the "Total Sums" in the latter for each observer excepting G show a decrease from left to right, that is, an augmentation of the reported strength of the odor, those in the former show no decrease, but rather a constancy or increase. Consistently with this, the increase (inhibition) for G in Table III is greater than the increase in II. It seems fair to conclude, therefore, that the decrease or augmentation in II probably was due to "added effort of attention in order to counteract the inhibitory influence of the sound," since upon removing this effort (at least partially at all stages) in Series II, that decrease disappeared.

However, the fact remains that the figures of the table do not demonstrate the general occurrence of inhibition of the odor sensation by the sound. We are reminded of the results of previous workers on distraction, who have failed to secure that condition under circumstances that made it expected. What makes our results almost astonishing, however, is that the inhibition did not occur when conditions were rendered so favorable.

We have attempted to carry out the conditions required for efficient distraction, as we previously defined them (*op. cit.*, p. 42). But it is possible that in one respect we somewhat failed. For upon exhalation through the nares a second olfactory stimulation sometimes causes a noticeable sensation, if attended, and this I did not take into account when I

¹G does not mention points (2) and (7); this may be due to omission, since her reports in this series lack fullness.

TABLE III.

		Observer B		Observer G		Observer E		
A	C	6	5	6½	6	7	7	
B	D	4	6	5	7	5½	4	
A+B	C+D	10	11	11½	13	12½	11	
E	G	4	6	3	5	3	4	
F	H	2½	2	1	4	1	½	
E+F	G+H	6½	8	4	9	4	4½	
A+B+E+F		C+D+G+H	16½	19	15½	22	16½	15½
A	C	7½	4½	6½	6½	6½	7	
B	D	4½	4½	2½	6	6	5½	
A+B	C+D	12	9	9	12½	12½	12½	
E	G	4	4	1½	4	3½	4½	
F	H	2	3½	2½	4	½	0	
E+F	G+H	6	7½	4	8	4	4½	
A+B+E+F		C+D+G+H	18	16½	13	20½	16½	17
A	C	6	5	7½	4	5½	6½	
B	D	6	5	4½	5½	4	4	
A+B	C+D	12	10	12	9½	9½	10½	
E	G	5	5½	1½	3	2½	3	
F	H	2	7½	1	1½	1	1½	
E+F	G+H	7	13	2½	4½	3½	4½	
A+B+E+F		C+D+G+H	19	23	14½	14	13	15
A	C	4	6½	6	7½	½	1½	
B	D	6½	6½	4½	1½	6½	5	
A+B	C+D	10½	13	10½	9	7	6½	
E	G	4½	3½	6½	4½	4½	2½	
F	H	4	1½	2	3	2	1	
E+F	G+H	8½	5	8½	7½	6½	3½	
A+B+E+F		C+D+G+H	19	18	19	16½	13½	10
Total		Total	72½	76½	62	73	59½	57½

planned the conditions. Nevertheless, there are two reasons for supposing it has not the greatest importance: first, since only one observer noticed it, and then said that it occurred but seldom; secondly, since we succeeded in getting inhibitions in Series III, as we shall presently describe, although the manner of exhalation remained the same.

We have not exhausted all resources for bringing about an inhibition of the odor by the sound. There remains one manner whereby we can increase the efficacy of this as an inhibitor to the maximum, and to this we now turn.

PART III

The Inhibition of Olfactory Sensations by Strongly Attended Sounds

§ 7. *Methods.*—Our aim was to learn whether the sound, when given the advantage of strong voluntary attention, would cause marked inhibition of the odor. If so, this would be like our previous results, where strongly attended sounds had inhibited pressure sensations, and conversely.¹

To do this, we find the number of times out of eight that the sensation from stimulus C accompanied by a strongly attended sound is called fainter than the sensation from S; also we find the number when C is not so accompanied, but receives normal attention. Thus we learn whether the attended sound increases the number of times that C is called the fainter. This plan was followed with four strengths of stimulus in the rôle of C, as Table IV makes clear. For S a constant stimulus was used in all cases for each observer, and the sensation was always attended in the natural manner.

TABLE IV.

	Observer B		Observer G		Observer E	
	First Odor	Second Odor	First Odor	Second Odor	First Odor	Second Odor
A	5	9	5	9	5	9
B	10	9	10	9	10	9
C	14	9	14	9	14	9
D	18	9	18	9	18	9
a	5/ <i>n</i>	9	5/ <i>n</i>	9	5/ <i>n</i>	9
b	10/ <i>n</i>	9	10/ <i>n</i>	9	10/ <i>n</i>	9
c	14/ <i>n</i>	9	14/ <i>n</i>	9	14/ <i>n</i>	9
d	18/ <i>n</i>	9	18/ <i>n</i>	9	18/ <i>n</i>	9

The figures stand for strengths of stimulus. The sound is represented by *n*. (In the last third of the present series we changed the strength of the second odor for Observer B from 9 to 6.)

Eight pairs of odors, along with repetitions, were given in succession, followed by a pause for rest. Before some sets the observer was told that the coming odors were to be compared and judged in the natural and ordinary manner; before other sets the instruction was as follows: "The sound will come with the first odor, and you are to put the most intense concentration you can on the sound. The second odor is to be attended in the ordinary way."

¹ Ibid., pp. 41-48.

§ 8. *Results*.—From the introspections we shall first quote accounts of the act of strongly attending the sound. Analysis shows that it involved various factors, differing from time to time.

Observer B.—"Concentration on the sound consists of clear auditory perception of the sound plus a visual image of the buzzer sometimes, plus kinaesthetic strains in head, ears, neck, sides of chest and elsewhere; probably also organic sensations in the trunk." So read his first report. He succeeded in carrying out the task from the start, excepting that at first he found that perfect concentration interfered with his withdrawing the nostril at the proper moment. He got rid of this difficulty by conceiving each time that the sound was caused to start by his act of placing the nostril on the tube, and caused to cease by its withdrawal.

Later on he adopts a similar device to help him attend to the sound. He will press on the table with his finger, he says, and the pressure will carry the meaning for him, "This is going to make the sound come." We can note the rôle of this and other elements in a report given at an advanced stage of the work. "In general, concentration on the sound came more easily than heretofore:—Auditory perception of the buzzer was clear sometimes, not very clear at others. There were kinaesthetic sensations in the right hand and fingers (meaning, 'I am pressing to make the buzzer sound.' The meaning just now was not so evident as it was earlier today, and has never been verbal today). The kinaesthetic sensations in the fingers last after the pressure sensations have become unclear, while muscular and kinaesthetic sensations in the chest, neck, left ear, cheek and shoulder (mean effort to attend to the buzzer; they also very vaguely mean the location of the buzzer, and occasionally become focal and mean 'I am leaning or trying to lean toward the buzzer'). Generally all these kinaesthetic and organic sensations are not very clear, though sometimes a particular one or a number of them stand out. When these are not clear, the clear process is either auditory sensations or visual image of the buzzer. Also there are very vague, never clear organic sensations in the head (which mean that the odor is present, but attended from,—like a feeling of bewilderment)." Much later we are told that the "pressure in the left hand is scarcely noticed any more, and occurs almost automatically, except after failure to concentrate." The factor is still mentioned at times in subsequent reports.

Of the period preceding the sound, an early report says: "I begin by calling up auditory images of the sound, and a visual image of the buzzer; the body is made tense, principally in the sides and back. In listening, strains of two kinds arise about the ears,—a sharper one on the pinna, and a duller and less intense one in the ear deeper than the external opening." Other reports show that all of these elements, excepting the auditory image, may also appear during the sound.

It is clear from the above analyses, as well as from many others which we have not the space to quote, that there are divers elements which enter into the act of concentration, namely:—

- (1) Clear auditory perception of the sound. (See Appendix § 9.)
- (2) Visual image of the buzzer sound.
- (3) Auditory image of the sound.
- (4) Kinaesthetic or 'strain' sensations about the ear (meaning attention to the sound).

(5) Kinaesthetic sensations in hand and fingers (meaning, 'I am pressing to make the buzzer sound').

(6) Tactual sensations, etc., (due to placing nostril on tube, and meaning that the sound will thereby be started).

(7) Kinaesthetic or 'strain' or 'organic' sensations in neck, trunk and limbs (mean effort to attend to the sound). (Appendix, § 10.)

(8) Organic sensations in the head and strains in upper parts of the trunk (effort not to attend to odor). (Appendix § 11.)

Observer G.—In the first report, in answer to the question, "What occurred when you concentrated on the sound?" it was said, "Muscular or strain sensations shifted from the region of the nostril to that of the ears. The sound stood out more in consciousness, as a rule, than the odor." Another report reads, "To get attention on the sound, I had strain sensations principally in and around the ears, especially the left. There were also strain sensations in the upper part of the head. These strain sensations were accompanied by the feeling that I must have my attention on the sound. Rarely the phrase, 'Sound!' or 'I must get the sound!' was present."

These reports, along with several others of similar tenor, do not enable us to enumerate as many factors as those for *Observer B*; certain other of her accounts mention various sensations due to tension in the arms, legs or trunk, but it is not made clear whether these are integral parts of the concentration on the sound or merely of the general attitude.

- (1) Clear auditory perception of the sound.
- (2) Muscular and strain sensations about the ear.
- (3) Strain sensations in the temples or upper part of the head.
- (4) Verbal idea, 'Sound!' or the like.¹

¹ The *Aufgabe*, we are told in the first report, was kinaesthetically rehearsed before each pair, "a shorthand anticipation of the whole process to be gone through,—the clearest part being strain sensations in the ear, with the accompanying feeling that the sound was to come first in the experiment, and strain sensations in the nostrils, with the feeling that smelling was the second thing. Sometimes, there was internal speech, 'Sound—odor'. Soon the matter becomes more automatic, but some strain persists right along."

In the above list of elements or parts of the act of concentration, we do not include everything that appears in the *Aufgabe*-consciousness. Rather, we distinguish between act of concentration and *Aufgabe* to concentrate as we would distinguish between 'effort' and 'feeling that I must exert effort'; the latter may be mere intention. To be sure, the consciousness of *Aufgabe* often is more than mere intention,—is itself an actual incipient effort to concentrate. Therefore the line is hard to draw and error may creep in.

Observer E.—In reply to the question, 'What happens during concentration on the sound?', a typical report from E reads thus: "Strain sensations in the eye-muscles (from moving the eyes toward the buzzer and from holding the eye-lids pressed on the eyes); also bodily sensations (from a muscular set in the trunk, head and neck generally, which carried the consciousness of the task to attend strongly to the sound); also sensations from changed breathing, which probably come from the body being held somewhat more tense."

From many such reports we abstract the following factors concerned in E's concentration:

- (1) Strain sensations about the eyes, and also sometimes in the

forehead and cheeks (from incipient turning of the eyes toward the buzzer).

(2) General, faint strain sensations in head, neck and trunk (they arise from a muscular set and are called by E the physiological accompaniments of attention to the sound).

(3) Vague visual image of the buzzer.

(4) Verbal kinaesthetic repetition of instruction, sometimes occurring as a memory image.

(5) The sound sensation is in the focus of consciousness; compared with what it was in the former series, it is more clear, its details and variations are more conspicuous, and it appears nearer at hand.

Having shown the nature of the act of strong attention to the sound, we turn next to inquire about the odor. How, according to the reports, was it affected in quality by the sound, and how was it attended, if at all, and how remembered? The reader is urged to have these questions in mind as he reads the following excerpts from typical introspections. In order to help him, we will first give a brief summary, of which the introspections may be taken as illustrations and extensions.

For B the odor may quite fail to appear during good concentration on the sound,—at most it is present without being clearly perceived; similarly for B it is not clear; but for E after some delay it arises clear and ‘near the focus, though just outside.’ Specific processes of attention to the odor are lacking, owing to the predominance of attention to the sound; this is true for B and G and at least in some measure for E.

The odor is referred to and remembered by an olfactory image, organic sensations, a kinaesthetic set, or visual images, that is, variously for each observer. The sound does not change the representation, except that in the case of B the processes are often much delayed.

Observer B.—“During the sound there are organic sensations in chest (?) and in head (?), which mean that the odor is present;—I am conscious of the odor, although not clearly conscious, for I do not know its intensity or quality. There are very strong organic sensations deep in the upper part of head, and also less strong muscular (?) sensations elsewhere (due to disturbance of respiration); both of these together mean effort not to attend to odor.”

Various other reports read quite similarly, e. g.: “The first odor varies greatly in clearness. I think there are at least two degrees of unclearness. The most unclear is hardly an odor sensation at all (if at all). However, there are organic sensations in the head (due to pressures) and less clear strains in back of neck and shoulders (all mean a pulling of the head away from the tube, or bracing it against force from the tube; also they carry the meaning, “The odor is present”). In this case I have no idea of the intensity of the odor until it is gone. Then appears an image of the odor with a more or less definite intensity. (Definiteness depends on clearness of image.)

“When the odor is actually recognized as such during successful concentration on the sound, it is vague and unclear, and varies in

intensity, generally becoming clearer toward the end. It has a certain intensity, though fine distinctions are not evident. —"

Later the observer comes to doubt very strongly that any odor appears at all when there is good attention to the sound; at any rate if it is present, he has no memory of it when he reports. After making further special observations on this point he decides that during some tests the odor is vague and unclear, while in others it quite fails to appear during the sound.

At most, then, the odor is vaguely present and dimly referred to by organic sensations. In contrast therewith we recall this observer's reports in Series 1, where processes of attention to the odor characteristically occurred. For example, "Organic sensations in the head and probably also in the body (meant effort to attend to the odor and to judge). Next came the olfactory sensation and, I think, a very vague, pale yellow image of the odor with the inside of the nostril as background. Then—general organic sensations arose (meaning effort to attend to the odor)—" etc.

Returning to the present series, we find that attention lapses to the odor only when the concentration on the sound is not successful. Then the odor "is clearly sensed in quality and intensity, and an 'absolute' judgment of intensity—generally in visual terms followed by verbal, but sometimes without the former—appears at once."

Another report, typical of many others, dwells on the rôle of feelings. "Sometimes organic sensations deep in the head mean that the odor is present. Occasionally the odor is sensed very vaguely and unclearly; I think I know that this is true only by a feeling of familiarity when I later recall the odor."

Ordinarily the odor comes up after the sound stops as an unfamiliar thing. There is a feeling of its unreality carried by certain organic sensations in the trunk. On the other hand, if concentration is not successful, the odor lasts over with a feeling of familiarity, but none of unreality. In this case there are feelings of exasperation, etc., organically carried."

We have room to quote only one typical report concerning the perception of the intensity of the odor. After taking the first breath and removing the head there were "organic sensations in the head and elsewhere and a vague visual image of a misty yellow field (?) with a bright spot in it (this meant 'I must get the odor,' the latter being represented by the bright spot). Next the olfactory image or sensation came in clear (representing the odor, of course). With this there was a visual image of a hazy yellow field plus organic sensations in the trunk (representing the intensity of the odor). At about this time the buzzer ceased."

This mode of representing the intensity of the odor is quite characteristic of this observer. But one important difference has been caused by the sound: the representative processes have been much delayed. When the sound is absent, they arise about at the time of inspiration, along with the odor sensation; but in the last quoted report the intensity of the odor is first represented at a comparatively late time, namely, considerably after the head has been withdrawn from the tube.

Observer G.—"When the auditory sensations were in the focus of attention, the odor was at a lower level." The odor, that is, appears on time, but is relatively unclear and unattended, because of the sound. "Muscular or strain sensations, instead of being around the nostril, shifted to the region of the ear," says an early report.

Little is said about the remembrance of the odor. Shortly after the odor has arisen, and while the sound is still in progress, there comes "a general organic feeling, which seems to stand for odor."

Observer E.—"The odor was generally clear; that is definite and clean-cut, of pleasant character and giving a feeling of certitude. This attitude can be analyzed into weak kinaesthetic sensations, not localized, accompanied by a pleasant affective coloring.—The sound has the focus of consciousness, but the odor is just outside of the center." Again, "the olfactory sensations come into consciousness, but seem never to get so near to the focus as do the auditory sensations." Later reports often agree that as the sound stops, the odor attains greater clearness; indeed, "they often become quite clear while the auditory sensations continue." This fair clearness of the odor makes it seem possible that there were specific processes of attention to the odor; but the observer did not mention them, so that they were probably not prominent; as no special question was put to him on this point, the matter remains in some doubt.

Let us pass on to another matter.—The memory of the first odor is once reported as having been carried by an olfactory after-image; but as a rule, the observer says, it is carried by 'a kind of kinaesthetic set.'

TABLE V.

		Observer B		Observer G		Observer E	
A	a	5 $\frac{1}{4}$	8	5	5 $\frac{1}{2}$	4 $\frac{1}{2}$	4 $\frac{3}{4}$
B	b	3 $\frac{3}{4}$	7 $\frac{1}{2}$	$\frac{1}{2}$	5	3 $\frac{3}{4}$	2 $\frac{1}{4}$
C	c	2 $\frac{1}{2}$	5 $\frac{1}{4}$	1 $\frac{1}{2}$	3	$\frac{1}{2}$	$\frac{1}{2}$
D	d	2 $\frac{1}{4}$	7 $\frac{1}{4}$	2 $\frac{1}{2}$	1	3 $\frac{3}{4}$	2 $\frac{1}{4}$
Sum		13 $\frac{3}{4}$	28	9 $\frac{1}{2}$	14 $\frac{1}{2}$	12 $\frac{1}{2}$	9 $\frac{3}{4}$
A	a	3 $\frac{1}{4}$	7	4	4 $\frac{1}{2}$	4 $\frac{3}{4}$	5 $\frac{1}{2}$
B	b	3 $\frac{1}{2}$	7 $\frac{1}{4}$	$\frac{1}{2}$	4 $\frac{1}{2}$	3	3 $\frac{1}{2}$
C	c	2	6 $\frac{1}{4}$	$\frac{1}{2}$	2	3	1
D	d	4 $\frac{3}{4}$	6 $\frac{1}{4}$	$\frac{1}{2}$	3 $\frac{1}{2}$	2 $\frac{1}{2}$	3 $\frac{1}{4}$
Sum		14	26 $\frac{3}{4}$	5 $\frac{1}{2}$	14 $\frac{1}{2}$	13 $\frac{1}{4}$	13 $\frac{1}{4}$
A	a	4 $\frac{1}{2}$	6 $\frac{3}{4}$	5	7	4	5
B	b	4 $\frac{1}{2}$	6 $\frac{1}{2}$	1 $\frac{1}{2}$	7	3 $\frac{1}{4}$	2 $\frac{1}{4}$
C	c	2 $\frac{3}{4}$	5 $\frac{3}{4}$	2	6 $\frac{1}{2}$	1 $\frac{1}{2}$	3
D	d	3 $\frac{1}{2}$	5 $\frac{1}{2}$	0	4 $\frac{1}{2}$	3 $\frac{1}{4}$	0
Sum		15 $\frac{1}{4}$	23 $\frac{1}{2}$	8 $\frac{1}{2}$	25	12	10 $\frac{1}{4}$
Total		43	78 $\frac{1}{4}$	23 $\frac{1}{2}$	54	37 $\frac{3}{4}$	33 $\frac{1}{4}$

For explanation of the table, see text. (See also Appendix, §§ 12 and 13.)

Now let us turn to our results in Table V. Considering those for Observer B, we have in the first column the number of times out of eight that C was called fainter than S, no sound

being given.¹ In the second column, the number of times that C was called fainter when the strongly attended sound occurred with it. It is evident that the values in the first column are considerably less than those in the second. C is called fainter more often with the sound; its intensity is reduced by the sound.² The results for Observer G are similar; those for E are different and require special discussion.

§ 9. *Discussion.*—First let us return and consider the list of elements of concentration given for Observer B (p. 358). Of these the visual and auditory images of the sound may clearly be classified as representative processes. Here we are reminded of Helmholtz's pre-imagination, of Lewes' preperception; we are confirming the views and experiences of previous writers. On the other hand the strain sensations about the ears and the kinaesthetic sensations in neck, trunk and limbs obviously are something more than merely representative in character; they indicate effort; they are motor adjustments to the sound. Here again, we are reminded of previous opinions; of Fechner's strain sensations, and of Müller's *Spannung* and *Anstrengung*. We come upon something new, however, in the observer's act of pressing upon the table to make the buzzer sound; and what is quite similar, his conceiving that the sound was caused to start by his act of placing the nostril on the tube. These acts are motor, but nevertheless they are also representative. And it is evident that it is by virtue of this representative character that they make the sound better attended. The observer deliberately associates the experience of placing the nostril on the tube with the sound, thereby doubtless severing its connection with the odor; thereafter the experience of placing the nostril on the tube suggests the sound and not the odor. The working of all representative processes clearly is to suggest the impression they represent; the process is one of "associative co-excitation."

If we compare the present series with Series II, where the attention was passive and effortless, we find in the latter very much less of these activities of representation and effort. The observer is not voluntarily attending to the sound, and the sound is less clear in consciousness. It is evident, therefore, that we were justified in considering the elements above dis-

¹ Refer to p. 346 and to Table IV.

² We do not mean that the sound has each time reduced the odor just so much; rather there is every evidence that the effect is very irregular. All that our figures permit us to conclude is that in the long run a considerable number of inhibitions occurred; that is, the odors would on the whole have had greater strength but for the sound.

cussed as essential parts of strong voluntary attention. In order to give them all a name, including the efforts and strains and the images as well, we note their property of making the sound prominent, of bringing it forward in consciousness; accordingly we shall call them 'adducent processes.' Now, what we wish to emphasize is that our results show that voluntary increase of the attention partially consists of increase of such adducent processes and that it is wrong to give them a minor or negligible place in a theory of attention, as is usually done.

According to E's reports the olfactory sensation during the sound was definite and clear, and though not focal was nevertheless nearly so. This is in sharp contrast with the cases of G and B and perhaps is the key to the difference of the results.

It is certain that the sound was strongly attended by E and we may assume from our results that the odor was nevertheless not inhibited. Neither, as the reports show, was it considerably less attended than when the sound did not occur. To generalize this result would be only to say that increase of attention to one impression does not necessarily bring inattention to another. The inhibitory effect need not in all cases occur,—unless that increase of attention be very great. Where it does occur, we may suppose, it is because the adducent processes for the one impression render impossible the other or inhibited impression. We do not suppose, that is, that under conditions like ours one sensation inhibits another by a direct or immediate action upon it, but rather by way of intermediate processes, those namely, which we have called adducent. Hence the unreliability of obtaining an inhibition merely by increasing the intensity of one impression or by increasing the attention to one impression; for whether this will bring with it that decrease of adducent processes required for inhibition is variable for individuals and for the particular mental complex of the moment.

§ 10. *Summary.*—In the first series we found that the strength of the odor sensation was not generally lessened by the sound; but rather it was increased for three observers out of the four. As there were indications that the distraction was being counteracted by effort of attention to the odor, the observers were next trained to abandon all effort. They found that the desired state was one of mental relaxation, and gave many analyses of this condition. But while the sound was now given a better chance to work upon the odor and

thus no longer lead to augmentations, it nevertheless still failed to produce marked inhibition.

Upon this, the observers were drilled in concentrating upon the sound as strongly as they could. Then the odor sensation generally suffered an inhibition, for two observers out of three. Analysis showed that the increased attention to the sound, upon which the inhibition obviously depended, consisted of representative and other processes associated with the sound, and to these the name 'adducent processes' was applied. The inhibition of sensations was thus found to be intimately bound up with adducent processes.

APPENDIX

§1. (Refer to p. 346.) The buzzer was placed in a box about 10x17x9.5 cm. in dimensions, the side next to the observer being open, and at a distance of 5 cm. from his left ear.

The olfactometer was clamped to an iron stand and adjusted to the height of the observer. It was fitted with a very large black screen, which served to shield the observer from odors as well as to conceal the operations of the experimenter.

For G we used beeswax, for E, India rubber, and for B and R, the combination of gum ammoniac and gutta percha. The last became weak after Series 1 and we obtained new ones from C. H. Stoelting Co., Chicago, which had a different quality of odor.

§2. (Refer to p. 347.) Concerning the time periods we note five points:—

1. We attempted to make the interval between the two odors to be compared fairly constant for each observer for every set of comparisons. (The signal to take the second breath was given a constant number of seconds after the beginning of the first inspiration.)

2. In order to equalize the periods of stimulation for the odors to be compared, the observer was given practice in making the second breath like the first. When deviations were noted we did not count the results.

3. In the process of smelling the observers at first took breaths of natural duration; but afterwards special drill was given in order to reduce the period, since we thought that we might more easily demonstrate inhibitions if we used brief sensations. (In Series 1-D, shown in Table I above, this period is one-half second for all observers; in 1-A, 1-B, and 1-C other, longer periods were used.)

4. Considerable effort was made to begin the sound at the instant when he breath commenced. (In this the experimenter was guided by the movements of muscles of the face and chest, by the sound of inrush of air into the nostril, and by learning with each observer how soon after the nostril was placed over the tube and in what position it was when he commenced to breathe.)

5. The sound always lasted at least as long as the inspiration. (After Series 1-A it always lasted longer,—in 1-D $1\frac{1}{2}$ seconds longer for all observers.)

Various other measures were taken to secure regularity of procedure, with the avoidance of error and disturbance:—

1. Eight pairs together with the necessary repetitions were given

in succession, followed by a pause for rest. As a rule for every A, B, E, and F there was a corresponding C, D, G, and H, respectively,—terms which are explained under Table I above. This was important because we thus got all the things we needed to compare into the same hour, and could therefore fairly disregard changes in subjective and objective conditions from day to day.

2. To avoid exhaustion, no more than 24 or 32 pairs of odors (not counting repetitions) were given during a single hour.

3. A clean tube was used after every eight judgments,—not counting repetitions, however, which were very frequent. Tests showed that with our odors, this rate of change was satisfactory. (The tubes were washed in a solution of mercuric chloride, an antiseptic which is superior to listerine because it is odorless. They were dried with cotton, and then heated in the flame of an alcohol lamp. In Series I we heated all just before the hour's work, but as this led to the collection of moisture we later abandoned the practice, and thereafter a tube was not put into the flame until we were ready to use it.)

4. A quiet room was used for the work. When unusual noises occurred we generally stopped or did not count the results. (Our reason for strictness lay in our previous experience that noises may affect the judgment without the observer noting this fact as such. Unfortunately our conditions were often imperfect, for there were times during the winter when we had to work with a continuous but faint rustling sound from the radiator, or with stronger noises from the wind outside.)

5. Repetitions were made (unknown to the observer) when unusual noises occurred, and whenever there was marked irregularity or disturbance. Also when the observer reported 'doubtful.' (Repetitions were frequent, though not the rule. In extreme cases a pair had to be repeated four times or more before the observer was satisfied with his judgment. The observers were cautioned to distinguish properly between the terms 'doubtful' and 'equal'.)

6. The experimenter gave the signals with no trace of suggestion in his voice. Also he took care to move the cylinder noiselessly over the tube when he changed the intensity, the observer assisting by calling attention to occasional failures.

7. To avoid suggestion, the aims and principles of the work were not mentioned to the observers, and they refrained from discussing the experiment with each other.

8. Drill was given to avoid expiration into the tube. (Failures were frequent and sometimes we had to stop work and give special practice.)

9. In order to escape unnecessary bodily activities, which might act as undesirable distractions, the observer customarily sat forward with eyelids lowered or closed, and nostril very near the tube, while he awaited the next signal.

§3. Since we quote many introspective reports in the present paper, we refer the reader to a recent article for description of technique which was, with some differences, the same as that herein employed (On Meaning and Understanding: this *Journal*, Oct. 1911. 1. *Introduction*, omitting (3) on p. 555). We may add that the observers were given special drill on the 'stimulus error,' on the distinction of different qualities of sensation in the various regions of the body, on attentional clearness, on the distinction between 'process' and 'meaning,' and in giving detailed descriptions of all the conscious

events as they took part in temporal order in the total process of preparing to smell, smelling, awaiting signals, judging, etc.

§4. (Refer to p. 351.) It is often difficult in describing the conditions of a psychological experiment to name all the factors that were effective in bringing about the attained results. Items of some importance are likely to escape notice. In this connection, we may take note of various elements present in this series in order to suggest to the observer the desired attitude: Signals were given in a quiet whisper, the experimenter tried to be deliberate and noiseless in his movements, and also by his general demeanor to impress the *Aufgabe*; the observers, on their part, undertook the difficult task with much earnestness, and continually tried to get or keep the desired condition. Before each set of eight comparisons, or oftener, the general instruction was always given, though usually abbreviated to a simple phrase such as "Your passive attitude!" The observer was advised to omit introspections in case preparation for these in any way interfered with the attainment of effortlessness.

§5. (Refer to p. 351.) Upon investigation I found that the observers generally had been judging intensities of sensations, not of stimuli (See L. J. Martin and G. E. Müller, *Zur Analyse der Unterschiedsempfindlichkeit*). As to the previous work (*op cit.*), I cannot say with certainty on this point. The difference between the two kinds of judgment is one of intentional reference;—one intends to judge stimuli, or on the other hand, sensations. Under our conditions the influencing factors are virtually the same for both kinds of judgment, so that there is no tangible difference in results, whichever reference is made.

§6. (Refer to p. 352.) Nevertheless, with an inconsistency that he admitted but could not resolve, he analyzed the feeling of relaxation into a complex of strain sensations.—"Was conscious of strains deep in the head, in the hands, legs, and trunk. I customarily describe myself as absolutely relaxed and comfortable while experiencing these strains. They seem to be merely those sensations that enable me to be conscious of my body at any time that I attend to it. They also form the positive element about relaxation that makes it possible to feel positively relaxed." At a later time he describes these 'relaxation strains' as "intermittent, thrilling sensations, very diffuse and vague, and generally pleasantly toned, having a general location but difficult to localize particularly, similar to sensations of nervousness, but entirely different from the 'dead weight' sensations that occur upon letting the arm fall."

§7. (Refer to p. 353.) On the fourth day of work the observer said that attention seemed less good than in the previous series. At the end she said that on the whole confidence in accuracy of judgment had been a trifle less.

§8. (Refer to p. 354.) To be considered with the foregoing are his replies to two questions.—What do you do when you attend to the odor? "(I hold the chest muscles more tense, and eliminate all movement except that required for the experiment); I often visualize the tube, stimulus, etc; also I generally have either an auditory memory image of the task or kinaesthetic sensations which mean the task and which produce a kind of set in which olfactory sensations are the things sought. This set seems somewhat to inhibit other things from coming to the focus of attention." He could not locate this set, but

said that it involved no effort. There was "slight effort in holding tense the muscles of the chest, but none in getting the auditory memory, or the visual image of the tube. This is all the effort I notice in the entire period, except that required to place the nostril over the tube, and to move the lips and tongue in giving judgment." Secondly, he was asked how he understood the term, 'effort'? "Something in addition to the automatic mechanical working:—Kinaesthetic sensations on either side of the chest carry the idea (of the end, namely, to breathe), which may be fairly clear or in the background of consciousness. Also there may be a vague auditory memory image (of the instructions) in the background."

§9. (Refer to p. 358.) We are not here trying to distinguish between perception and sensation, for the observers have not been drilled on this point. (Cf. this JOURNAL, Oct., 1911, 558).

§10. (Refer to p. 359.) We intend (7) not as a label for a particular experience, but as a rubric. Several experiences already mentioned fall under it, and we will here give two more instances. "——strains and muscular sensations in arms, hands, head and neck (mean effort to attend to the buzzer, or determination to succeed)." Again, "muscular sensations in left side of trunk and left side of head, strong tactual sensations, also sensations in the lobe of the left ear and organic sensations deep within the head,—all seem like strain toward the left; (the whole complex means attention to the buzzer)."

§11. (Refer to p. 359.) 'Attention away from' is not the same as mere absence of attention to; they differ as turning away from a thing differs from not turning to it. Here are further instances: "Organic sensations in the head (pressures) and less clear strains in the back of the neck and shoulders; (the complex of strains means pulling the head away from the tube, or bracing it against force from the tube; the strain sensations together with the organic carry the meaning, 'The odor is present')." Again, "Very strong organic sensations deep in the top of the head, as well as less strong muscular (?) sensations (due to disturbance of respiration) (mean effort not to attend to the odor)." Several times the attention is turned away from something indefinite: "A complex arose similar to that of tilting the head back (meaning attention from something)." (What was that something?) "It was indefinite." To this he adds, mentioning an emotion, "Organic sensations in the trunk, I think, meant fear of attention to." Sometimes in this connection he speaks of bewilderment.

§12. (Refer to Table V.) We need to explain how the fractions $\frac{1}{2}$ and $\frac{1}{4}$ come into this table. The former is due to our counting the judgment 'same' or 'equal' as equivalent to $\frac{1}{2}$ stronger, or $\frac{1}{2}$ fainter. Occasionally, however, the judgment given is 'equal or fainter' or 'equal or stronger.' In Series I and II I classified such cases as doubtful and repeated the test. But in fact when the observer says 'equal or fainter' he definitely means 'not stronger,' and is not in doubt of at least so much; therefore I counted this judgment as half way between equal and fainter, that is, $\frac{3}{4}$ fainter. The matter, I admit, is debatable; but whatever stand we take is not of much importance for our present work, since such judgments were unusual and our figures are therefore little affected by this way of counting.

§13. (Refer to Table V.) After saying which odor was stronger the observers each time reported whether attention on the sound had been successful. In case of failure we repeated the test. Observer G was not asked to give such reports until the series was almost half over; but apart from this we made it a rule to obtain them. Where repetition is thus made the judgment in the second case may differ from the first. The figures in Table V represent the approved conditions, namely successful concentration on the sound, except for G as above noted. Our figures would have been virtually the same for G and E even if these repetitions had been omitted; but for B there is some difference: had we counted his first judgment in all cases regardless of whether attention on the sound had been good or bad, the figure for the 'Total Sum' of the second column would be 68 instead of $78\frac{1}{4}$. The repetition leading to improved concentration on the sound also leads to greater inhibition of the odor. Another set of figures for B, not included in the table, shows the same results.